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# RECLAMATION



Kathleen Wood Loveless, Editor

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# OLD SEEDINGS RESCUE MISSION



By J. HUNTER HOLLOWAY, *Writer-Editor, Division of Atmospheric Water Resources Management, Bureau of Reclamation, E&R Center, Denver, Colo.*

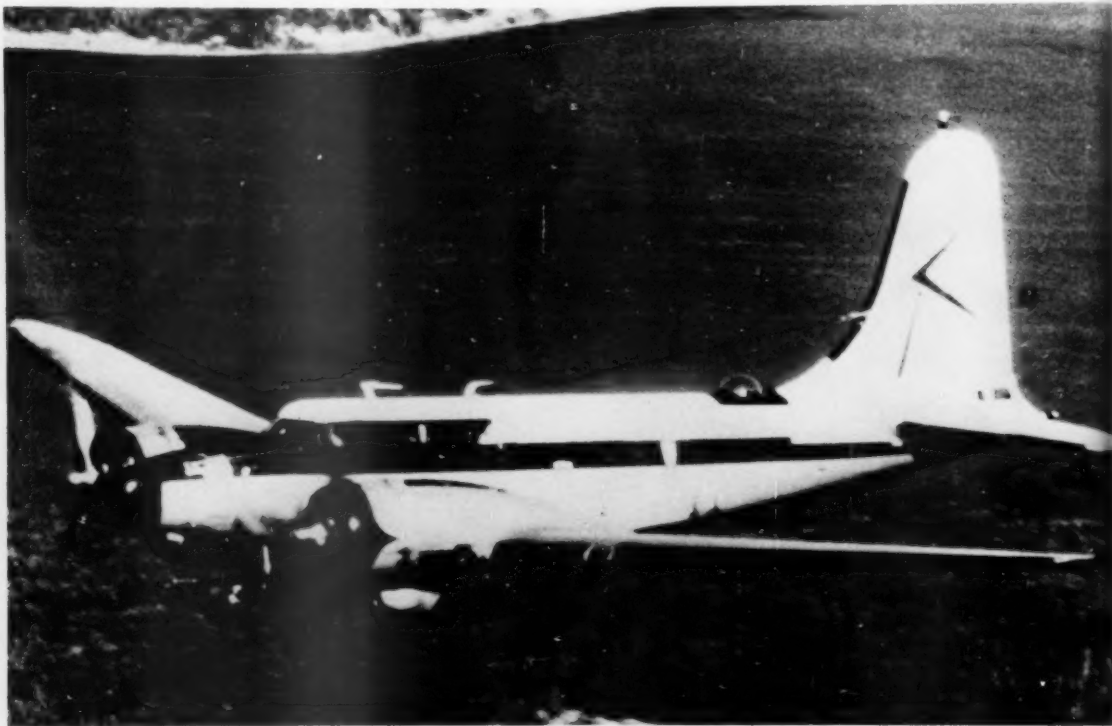
High over the Cascades, where winter storms vent their fury in snow and ice, weather modification tamed Mother Nature for 40 minutes last January—long enough to rescue three men from a crashed airplane.

On January 2, 1973, Bob Spurling of Seattle at the controls of a vintage B-23, piloted the research plane and its crew of scientists through clouds and over the

ment precipitation.

At about 1:40 p.m., the plane was in its second seeding pass at 10,000 feet on a line from Ellensburg to a point 10 miles west of Hyak. A man's voice over the radio shouted the distress call, "Mayday!" Suddenly, routine research became emergency action.

"The call came from a light aircraft which had run out of fuel over the central Cascades just south of our position," said Dr. Lawrence Radke, a research scientist aboard the B-23. "Our aircraft immediately vectored a radio relay link between the distressed aircraft and the Seattle FAA control center."



*The University of Washington's vintage B-23, equipped with sophisticated instruments for weather modification research, seeded clouds to rescue three downed fliers.*

Cascade Range in central Washington. Their mission for the Bureau of Reclamation was to learn more about seeding clouds to increase snowfall and to study snowflake trajectories.

### *Began as a Routine Flight*

It had been a routine flight for the six-man crew, four of whom were scientist members of the University of Washington's research team working under the Bureau's Project Skywater. Project Skywater is the Federal program to explore, develop, and eventually apply the technology of weather modification to aug-

Like a mother hawk, the twin-engine B-23 circled above the disabled Beech Bonanza as the single-engine craft glided out of sight into the top of the clouds. "We provided directions and approximate turn times to help the fuelless plane descend through the heavy cloud cover and avoid the 5,000- to 6,000-foot peaks in the area," Radke said.

"Our hope was that we could guide them to Hansel Reservoir, an ice-covered lake in a deep valley at about 1,500 feet elevation," Radke continued. The light plane, with its pilot and two passengers broke through the bottom of the cloud at about 2,700 feet

## Heavy Mist and Ice

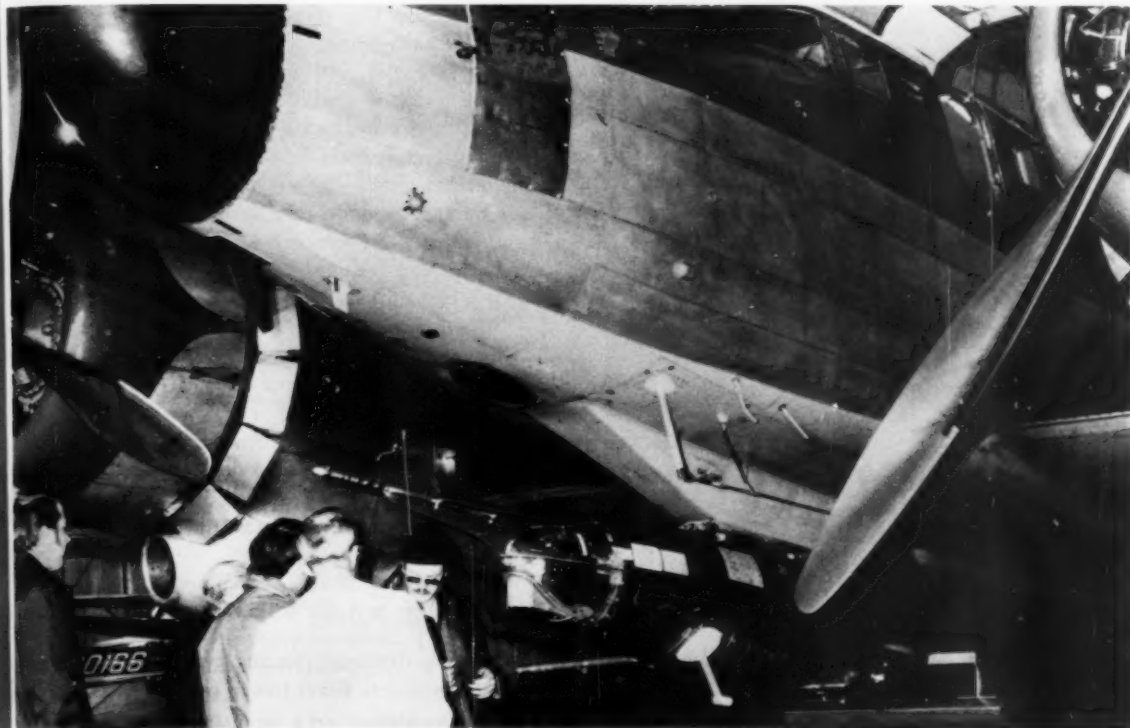
Jim E. Brackett, the pilot and a math-science instructor at Upper Columbia Academy in Spangle, Wash., said he attempted to stretch his glide path but had limited visibility because of heavy mist and ice. "When we broke out of the clouds," he said "the windshield was iced. I couldn't see very well." He realized the mist was hiding nearby ridges, but spotted a snow-covered area about 7 miles southeast of the reservoir.

The small plane bellied into the snow and skidded about 100 feet across a series of tree stumps, remains

vide the necessary radio link until an Army Reserve Chinook helicopter from Sand Point Naval Air Station arrived. Brackett explained later that his undamaged radio was able to pick up weakly the FAA messages, but was unable to transmit over the nearby ridges to Seattle.

"At that point," Radke said, "the FAA released us from emergency procedures and we returned north to Hyak to resume the seeding experiment. This effort proceeded for only about 15 minutes when we were recalled by the FAA to assist in the rescue."

"In our role as orbiting radio relay," Radke said,



Weather instruments are clustered about the nose and undercarriage of the B-23 weather research aircraft.

of a logging operation. The plane suffered extensive damage.

### Not Injured

"Surprisingly," Radke related later, "the three men in the aircraft were uninjured and their radio was still operating but could not be used to communicate directly with the FAA." The three men, Brackett; Ray Duttero of Kirkland, Wash.; and Berni Niel of Bellevue, Wash., were returning to Seattle after a skiing trip in Utah.

Radke said the B-23 remained in the area to pro-

"we became convinced that the aircraft was down well north of the assigned search area, so we flew a box search until we passed directly over it."

### Forced Landing

"Referring to our aircraft position plotter, we reported the new fix to both the FAA and the helicopter. However, in trying to move north, the Army helicopter encountered severe icing and made a forced landing to clear off the ice," Radke said.

A second helicopter, a Chinook from Sand Point, was sent to the area, but was also hindered by icing.

Radke said, "We suggested to the FAA that we could probably make a hole in the clouds over the downed aircraft by artificial seeding."

*Dr. Lawrence Radke, a research scientist for Project Skywater, directed the rescue mission from this work area inside the B-23.*



In Seattle, FAA officer Hal Morril said later, "We were about ready to try anything—even seeding with iodine or whatever they use."

The B-23 is a weather-monitoring aircraft, equipped with sophisticated instruments for the Skywater research program. It also is capable of dispensing silver iodide or dry ice, seeding agents which serve as artificial ice nuclei and stimulate precipitation.

### *Overseeded*

"With skeptical approval from the FAA," Radke said, "we heavily overseeded with dry ice along a line about 2 miles long immediately upwind of the crash site." The dry ice was released at a rate of 40 to 50 pounds per mile, instead of the less dense and more common rate of 1 to 20 pounds per mile. The heavy charge of dry ice had a shotgun effect, rather than the prolonged snowfall which can be stimulated by lighter amounts.

On the ground, Brackett said he was aware the B-23 was involved in weather modification research. "I knew he had seeding equipment," the teacher said, "but I had no idea he was using it."

"We first realized he was seeding," Brackett said, "when the sky began getting bright. After it began to clear, we could see the area was nearly surrounded by ridges."

As visibility improved, Spurling skillfully put his B-23 into a tight circle and descended into the hole. While the twin-engine craft bored into the cloud like a huge auger, dry ice was seeded into the cloud's side walls.

### *The Clouds Parted*

"A fairly dramatic clearing resulted and we were able to descend to 6,000 feet in reasonable safety. We spotted the aircraft on a small ridge southeast of the lake, exactly where we had reported it, and we cleared a nice, big hole for the helicopter."

"We then guided the helicopter along the valley floor and up into our seeded hole to the downed aircraft," said Radke.

The difficulty in finding the crashed plane in mountainous terrain was emphasized when the Army helicopter flew past the light-colored wreck, passing within about 100 yards without spotting it.

The helicopter, however, was directed back to the damaged plane and landed without additional difficulty. Brackett and his two companions were taken onboard and flown to safety. The plane was removed from the ridge several weeks later by a commercial helicopter.

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*This type of hole was cut through a cloud deck over the Cascade Mountains January 2 which enabled a helicopter to rescue three men.*

### *Right Place at Right Time*

Dr. Peter V. Hobbs, the project's principal investigator, monitored the drama on a radio in his office. "We, of course, usually seed clouds for research purposes," he explained. "This is the first time we were asked to do it for operational purposes. This sort of thing happens once in a lifetime—being in the right place at the right time."

Dr. Archie M. Kahan, Chief, Division of Atmospheric Water Resources Management of the Bureau of Reclamation and a licensed pilot, believes there is a future rescue role for cloud seeding.

"There's no reason in the world," he said, "why rescue helicopters couldn't be equipped with self-contained seeding equipment. First, however, individuals involved in air rescue work should be instructed in the principles of cloud seeding and receive guidance from responsible sources."

A simple carbon dioxide fire extinguisher could be used to cut holes in some cloud decks, Kahan explained. He recalled that several years ago while flying with a pilot, the man said he had used a CO<sub>2</sub> fire extinguisher to cut a hole in a cloud deck over Alamosa, Colo. The hole enabled the pilot to safely land his

single-engine plane. Kahan stressed, however, that weather modification is still a new science with much remaining to be learned. Indiscriminate seeding must be avoided.

### *Flattening Trajectories of Snowflakes*

Hobbs, an investigator in atmospheric sciences, and his staff have spearheaded research into a unique form of weather modification—the science of flattening the trajectories of snowflakes, an atmospheric transbasin diversion of water resources.

The objective of Hobbs' and Radke's program is the development of techniques by which atmospheric moisture can be diverted from the wet western slope of the Cascades to the dry eastern slope during the winter. Actual field activities are conducted by Hobbs, Radke, and their staff under a subcontract with the State of Washington, Department of Ecology.

Data from the B-23 and other weather-monitoring systems are entered into a computer program, which calculates the location and altitude for aircraft to release seeding material so snowflakes trajectories will deposit them on the eastern slope. Results to date are promising.



By **EDWIN W. CRAMER**, *Natural Resource Specialist, Bureau of Reclamation, Lower Missouri Region, Denver, Colo.*

Wyoming Reclamation reservoirs are well known for the excellent fishing opportunities they offer. Sometimes, however, this fishing excellence is interrupted by the emergence of a biological imbalance. This happened twice at Glendo Reservoir, a large Reclamation reservoir on the North Platte River in eastern Wyoming.

Since the people of Wyoming are trout lovers and the water conditions were suitable, a rainbow trout fishery was established at Glendo Reservoir. Starting in 1957, large quantities of rainbow trout fingerlings were planted in the reservoir by the Wyoming Game and Fish Department. Glendo promised to be one of the finest rainbow trout fishing waters in the State.

### *What Happened?*

The first few years fishing was tremendous at Glendo, but it dropped off sharply by 1964. The big question was "What happened?". The Wyoming Game and Fish Department began studies to answer this question and to find a solution.

# Wyoming Big Fish Story

The villain turned out to be yellow perch. Now yellow perch isn't necessarily a bad fish; as a matter of fact, in some areas of the country yellow perch are considered desirable game fish. Under some conditions, however, they become a nuisance to themselves as well as to other fish species.

Yellow perch eat essentially the same food as rainbow trout, thus a direct competitor for survival. Their diet includes small fish, aquatic insects, microscopic plants and animals, worms, clams, and snails. In addition, yellow perch reproduce to such an extent that they literally overpopulate their environment. When this happens, the result is stunted perch about 4-6 inches long.

### *Yellow Perch Overpopulate*

Studies indicated that stunted yellow perch made up about 60 percent of Glendo Reservoir's fish population while the popular rainbow trout made up only 2 percent. The remainder were mostly carp and suckers, which are also undesirable species.

While it is not known for sure how yellow perch got into Glendo Reservoir, it is believed they were either brought in as live bait and released, or illegally

planted by fishermen from some neighboring State where yellow perch is more highly regarded.

Before it was decided to use chemicals to rehabilitate Glendo waters, two other methods were tried to reduce the yellow perch population. The Wyoming Game and Fish Department contracted with commercial seiners to remove the unwanted perch, but this proved unsuccessful. Then, the stocking size of rainbow trout was increased on the theory that the larger fish could better compete, but yellow perch still won the battle.

### *Remove All Fish*

Fishery personnel conceded that the only solution was to remove all fish from the reservoir by chemical means and to start again with rainbow trout. So the reservoir was chemically treated in September 1966. Everyone concerned with the project realized that this would not be a permanent answer to the problem as undoubtedly the reservoir would be reinfested with undesirable fish species. It was hoped, however, that the rehabilitation program would provide improved sport fishing for 5-6 years.

The chemical selected for the job was rotenone, a derivative of the tropical derris plant. Rotenone affects the respiratory system of fish, making it impossible for them to take oxygen from water, thereby suffocating them. Even dead, however, the fish are perfectly safe for human consumption. The period of toxicity to fish in the reservoir was approximately 1 week with no undesirable residual effects.

### *Rotenone, A Toxicant*

Rotenone has been used as a fish toxicant for years and is considered safe. It was applied in a number of ways in Glendo Reservoir. The chemical was introduced at a predetermined rate into the river above the reservoir through hoses and valves suspended over the river on cables. An airplane sprayed the surface of all isolated ponds and shallow water within the reservoir area. The reservoir proper was treated by feeding rotenone into the prop wash of the boats used. Barge-mounted pumps were also used to flush the toxicant under the surface in the deeper waters of the reservoir.

The Bureau of Reclamation manipulated its operations through the preceding year in order to draw down Glendo Reservoir to a minimum level and also to reduce the flow of the river for the treatment day in late September. This was essential to make the rehabilitation program as economical as possible since the

amount of rotenone needed depended upon the quantity of water to be treated.

### *Project Seemed To Succeed*

The project seemed to be a success. Observation made during the treatment and gill-net samples taken later indicated that the control obtained was excellent. Five weeks after the treatment, 600,000 large rainbow trout fingerlings were planted in the river section above the reservoir. Additional plants were made in succeeding years.

Glendo Reservoir had been restored to a respectable rainbow trout fishery. Fishing remained good through 1970. But then, as had been predicted, a population explosion of yellow perch again ruined trout fishing.

### *Predator Fish Used*

Another fishery rehabilitation program was planned for Glendo Reservoir. This time, however, a different concept of fishery management was introduced. Instead of relying solely on chemically treating the reservoir and restocking only with rainbow trout, fisheries biologists decided to control undesirable species by using a predator fish as well.

The plan was to rid the reservoir of its entire fish population and start over with rainbow trout and walleyed pike (a pike perch). It was expected that the fish kill would be complete enough to provide a good trout fishery for a period of 5-6 years. By that time, it is hoped, the walleyes will develop into an effective control on the perch. While the walleyes eat a wide variety of food, the fish most often found in the stomachs are minnows, suckers, sunfish, and yellow perch.

### *Try Again*

The Bureau again cooperated by operating the North Platte River system in such a manner as to draw down Glendo Reservoir to a minimum level by September 1972. As before, the Wyoming Game and Fish Department treated the waters of the reservoir with rotenone. Excellent results were achieved in drastically reducing the undesirable fish population.

After the treatment, Glendo Reservoir was restocked with about 1,300,000 large sub-catchable rainbow trout, 48,000 catchable rainbow trout, and 200 adult walleyes.

If everything turns out as planned, Glendo Reservoir should once again become one of the "hot" fishing spots in Wyoming.

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JAPANESE COMPANY DEVELOPS NEW PLASTIC WATER CONVEYING PIPE

UNIQUE  
PIPE  
DISCOVERY

By WILLIAM A. LIDSTER, Bureau of Reclamation  
Regional Representative Open and Closed Conduit  
Systems Committee

Fall opened quietly in the small rural community of Haig, Nebr., but closed with a bang when Haig became the hub of international activity last November.

The event was the first installation of a unique PVC (polyvinyl chloride) pipe. Approximately 150 representatives of pipe manufacturers, petroleum corporations, plastic companies, consulting engineers, contractors, irrigation districts, and Reclamation representatives from all parts of the United States and Japan traveled to this rural community in western Nebraska to witness the event.

It was not the installing of the PVC pipe per se, but the pipe's unique properties, that made this demonstration of interest to such a large cross section of the United States and Japan.

### *Soft State*

The pipe is manufactured in a soft state that can be coiled or folded for shipment. It is hardened by a heat process at the construction site and, while still warm, is rounded by air pressure. The pipe obtains its design stiffness in a matter of minutes.

### *Made in Japan*

This unique pipe is a new product developed by a company in Tokyo. First manufactured 2 years ago, it is now sold in Japan by special order only. The first installation outside Japan was made in Saudi Arabia to test the suitability of the pipe in extremely hot climates.

The United States was chosen by the manufacturer as a second demonstration site. It was chosen because of the current demand for an economical pipe for conveying water and because of the savings obtained through rapid installation of extremely long lengths of pipe.

With the growing need for irrigation districts to convert their open laterals into closed pipe systems and the increasing number of rural counties forming water districts and constructing potable water systems, what better place could have been selected for this demonstration than rural America?

### *Installation*

The only limitations on the length of this reinforced, jointless pipe are the size of the shipping container and the mode of transportation. For this demonstration, a continuous 3,300-foot length of 16-inch pipe without joints was folded accordion-fashion and shipped from

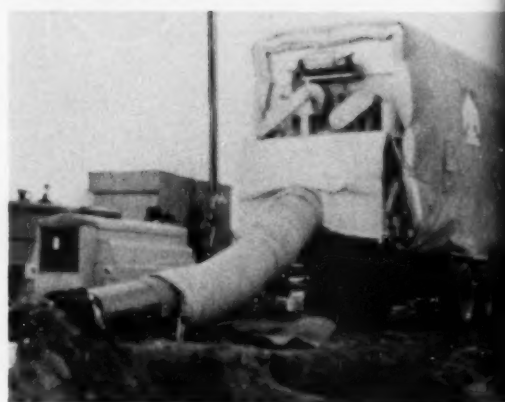
Japan in a 7-foot-wide, 40-foot-long, 15-foot-high container that could be loaded onto a standard flatbed trailer.

This container was insulated at the jobsite, covered with a plastic cover, and converted to a heating box to heat the pipe. The pipe was heated to about 180° F. to fuse the plasticizer and resins which converted the soft pliable pipe into a hardened finished product. The heated, flattened pipe was dispensed through mangle and rounded by inflating the warm pipe by an air compressor supplying air at 5 to 10 pounds per square inch.

Onlookers saw the fully inflated pipe come out of the pipe guide and slide directly into the trench. The pipe

Top. Pipe is loaded onto a standard 8-foot by 40-foot flatbed trailer.

Bottom. At the construction site the container was converted into a heating box by covering it with fiber glass insulation and plastic tarpaulin. The insulated pipe guide was used to keep the pipe warm while being inflated and rounded by air pressure.



develops its stiffness as it cools. The cooling time for the pipe depends on the weather. The temperature during this installation was about 30° F. At this temperature the pipe developed its full design stiffness in about 3 minutes.

The pipe was processed and installed at the rate of 20 feet per minute. The maximum speed the pipe can be processed and installed at the jobsite is 50 feet per minute. At these speeds, the pipe can be laid faster than with conventional trenchers; therefore, the pipe should be ideally suited for use with a high-speed trencher or a mole plow. The manufacturer plans to make the pipe from 1½ inches in diameter to 200 inches in diameter. Presently, the maximum size manufactured is 48 inches.

### Joint Venture

In our never-ending search to find new products that will benefit irrigation districts in the operation and maintenance of their systems, the Lower Missouri Region discovered this new product with the potential to reduce the cost of converting existing open lateral systems to closed pipe systems.

To highlight the need for new products that could benefit irrigation districts, the Lower Missouri Region sponsored this joint venture between Mitchell Irrigation District, Nebr., and the Japanese company under the FY 1973 Open and Closed Conduit Systems program. Staking out the line, excavating, and backfilling the trench were accomplished by the Irrigation Dis-

*While still warm, the pipe was inflated by 10 to 15 pounds per square inch pressure supplied by an air compressor.*



*The pipe is manufactured with air vents to evacuate the air as it is folded for shipment. This technician is installing plugs as the inflated pipe is being extruded.*

trict. About 30 miles of buried pipe laterals will be installed to replace the open lateral system. The Japanese company supplied the pipe, all equipment for heating and installing it, and a crew of technicians from Japan who assembled the equipment and laid the pipe in the trench.

### Who Benefits From Such Demonstrations?

First, this demonstration will benefit irrigation districts by showing industry that equipment and products are needed to provide more economical methods of converting the older, open lateral systems that are expensive to operate and maintain into more efficient closed systems.

Secondly, states such as Nebraska could benefit by having more industry brought into the area. Companies with new products contributing to lower costs in the rehabilitation of existing irrigation systems should investigate the possibility of manufacturing their products where the cost of land is reasonable, availability of manpower is plentiful, and the product need is great. Nebraska is just such a place.

# YESTERDAY IN OUR MAGAZINE

## THE RECLAMATION ERA—1952

### *Super Water Highways*

*by Roy Johnson, President of Sandkay Contractors*

The Main Canal, a four-lane water highway on the Columbia Basin project, and wide enough to carry four lanes of auto traffic with room to spare, now is ready to carry life-giving water to 87,000 acres of land in the State of Washington.

This tremendous irrigation system starts from Grand Coulee Dam to water more than 1,000,000 acres of the fertile soils of the Columbia Basin. These concrete-lined canals remind one of the super highways, or more appropriately, of "super water highways." The bottom width of the largest of these canals is wider than necessary for four lanes of cross-country traffic and, over the entire concrete-lined perimeter, 12 lanes of traffic could be handled with ease.

That is the picture now, but the scene has changed greatly from the time the first survey crews worked from ropes along 100-foot-high rock cliff sections to insure a uniform grade to carry the flow of water to its destination many miles away. . . .

Completion of this canal system left the super water highways as you see them today, but you will also find 3 mile-long tunnels 25 feet in diameter through solid rock hills, and concrete siphons 25 feet in diameter and 2½ miles long across valleys, all of which help make up a great monument that far-sighted engineers challenged the construction men to build.

This monument and others still in the minds of engineers or on drafting boards will make better living for a prosperous and progressive country.



# TODAY

## RECLAMATION ERA—1973

### *Today's Canals*

In furthering that 1952 goal to make better living for a prosperous and progressive country, the Bureau of Reclamation has found another use for its canals.

The Bureau now has a 3½-mile dual purpose canal which not only supplies irrigation water as in 1952, but also has deep gravel beds for salmon spawning.

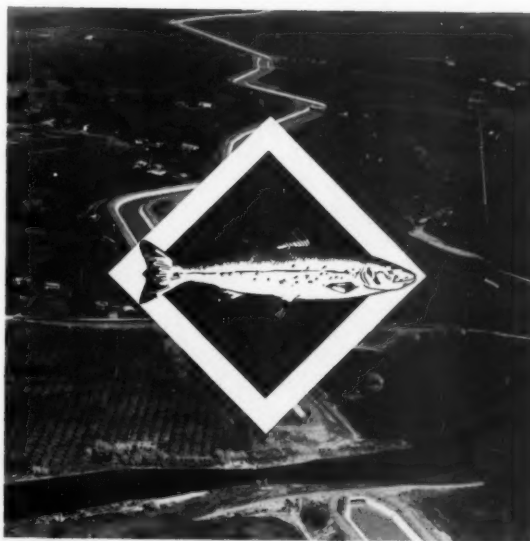
Oxygen-rich water from nearby Shasta and Trinity reservoirs, features of the Central Valley project, is released into the 6- to 8-foot-deep concrete-lined canal. Carefully selected gravel about 2 feet deep lays on the bottom creating spawning beds.

Carefully worked out with the U.S. Bureau of Sports Fisheries and Wildlife and with California State scientists in cooperation with Reclamation engineers, the artificial spawning beds may serve salmon better than do natural streams.

Fishery biologists will select prime salmon attempting to reach former upstream spawning areas, and these selected salmon will be the first permitted to enter the new beds. Biologists expect that an attractive breed of "Tehama-Colusa" salmon will result.

Salmon fingerlings are apparently "imprinted" by the quality of water so that they will return from the Pacific in 3 or 4 years as adults to seek the precise areas in streams where they originated. This will bring an estimated 40,000 salmon a year into the canal, to lay 140 million eggs.

Today canals are still being constructed in four-car-lane widths but, unlike 1952, some canals are being used as salmon beds, too!



A  
summary of  
its impacts  
and future  
considerations

# The Federal Reclamation Program<sup>1</sup>



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The Federal Reclamation Program has operated for 70 years to develop the West. Since its establishment in 1902, 150 water resource development projects or units have been placed in operation at a national investment of about \$6 billion.

This investment has resulted in the construction and operation of 217 reservoirs, 131 diversion dams, 6,686 miles of canals, 50 hydroelectric powerplants, and over 16,000 miles of transmission lines. These features do not include powerplants with over 2 million kilowatts of capacity or numerous other facilities constructed or operated by others than the Bureau of Reclamation, which operate as part of Reclamation projects.

Nearly 9 million acres of western farm land receive full or supplemental irrigation water, 168 communities receive municipal and industrial water, 54 million visitor days of recreation are recorded annually, and 7,490 megawatts of installed hydroelectric power capacity.

### *Special Features of the Reclamation Program*

The original intent of the Reclamation Program was to help settle and develop the 17 Western States by providing water for irrigation. Earlier efforts at providing irrigation water were not properly financed, and the project failure rate was high.

Another feature of the Program is its recovery of a major portion of its costs. Originally, water users were to repay the Government for all costs although no interest charges were imposed. As law and policy were revised and broadened over the years to accommodate multiple purposes, some Program costs became nonreimbursable. Repayment of the investment (\$1.1 billion of a \$6 billion total has been repaid thus far) is designed to recover about 90 percent of all capital costs.

A third feature of the Reclamation Program is the extensive economic analysis undertaken for each proposed project. Analysis of project benefits and costs has been conducted since the early 1940's. The methods of analysis have undergone substantial change over the years, and are currently going through another major revision, but the basic principle of looking at both costs and benefits has been used for over 30 years.

### *Policy and Program Objectives*

The Federal Reclamation Program was formally launched with passage of the Reclamation Act of 1902.

<sup>1</sup> This summary was developed from a report, *The Federal Reclamation Program—Its Impacts, Issues, and Future Considerations*, prepared by Dean C. Coddington, Harold L. Davis, and J. Gordon Milliken, December 1972.

The Nation's economy at that time was primarily agrarian and the most important industry was agriculture. Almost 40 percent of the labor force was engaged in farming, in contrast to present agricultural employment of less than 5 percent. In essence, the Reclamation Act provided that proceeds from the sale of public lands were to be set aside in a fund to finance the construction and maintenance of irrigation works in the arid West, and that expenditures from the fund would be repaid by the settlers in a 10-year period.

Furthermore, each settler receiving title to land was to comply with the 160-acre limitation required by the Homestead Law of 1862. The requirement of full repayment of costs by beneficiaries was unique. It contrasted with national policy at that time which treated investments in navigation and flood control as non-reimbursable.

It soon became apparent that it would not be possible for settlers to repay full construction costs in a period as short as 10 years. Also, it was evident that the Reclamation Fund would not be self-sustaining since repayments by settlers and proceeds from sales of public lands would be insufficient to finance major irrigation works. An advance of funds was sought from Congress and the repayment period was lengthened from 10 to 20 years.

The value of water for power generation was recognized in 1906 through legislation permitting the sale of electric power surplus to project needs. Depressed agricultural conditions after World War I caused repayment problems and led to passage of the Fact Finders Act of 1924. This act embodied several basic reforms including land classification, assessments based on farm returns, and rigorous standards for project feasibility.

### *The Depression's Effects*

The Reclamation Project Act of 1939, encouraged by the Great Depression of the 1930's and the floods and drought in the West, set new goals for Reclamation such as providing for storage and delivery of municipal and industrial (M&I) water. The Depression gave much impetus to the Reclamation Program by stimulating great multipurpose undertakings such as Grand Coulee Dam and powerplant on the Columbia River and the Central Valley project in California.

The Act updated and modified previous Reclamation law and clearly revealed the concept of multipurpose development. It permitted nonreimbursable cost allocations to navigation and flood control, and provided that revenues from surplus power and M&I water could be used to repay irrigation costs.

## Preservation of Wildlife and Fish

In 1946, the multipurpose concept was broadened to include the preservation and propagation of fish and wildlife. In 1965, the Federal Water Project Recreation Act provided for the acquisition of lands and construction of specific facilities for recreational use and fish and wildlife enhancement. With the added features of multipurpose projects, including hydroelectric power and new emphasis on M&I water, the proportion of Reclamation funds allocable to irrigation has gradually declined.

## The Changing Nature of the Reclamation Program

The shift in emphasis from agriculture to M&I water and recreation has been significant. In fiscal year 1960, 60 percent of total program costs was allocated to irrigation and 28 percent to power. Ten years later, 50 percent of all costs was allocated to irrigation and about 25 percent to power. The remaining 25 percent was allocated to M&I water service, flood control, fish and wildlife enhancement, recreational facilities, and other purposes.

## The Five Basic Outputs

The five basic types of output from Reclamation projects are M&I water, hydroelectric power, recreational facilities (including fish and wildlife), agricultural water, and flood control.

Traditionally, the primary activity has been irrigation by providing a full water supply for new lands and supplemental water for irrigated areas having inadequate supplies. In 1970, 4.0 million acres of land received a full water supply and 4.5 million acres were furnished supplemental water by Reclamation projects. These lands produced \$1.9 billion in gross crop values.

The generation of electrical power is an important purpose of several Reclamation projects. Installed capacity in the 50 Reclamation hydroelectric plants operating in 1972 totaled over 7,600 megawatts.

Almost all Reclamation projects are used for recreational activities. Visitor days at 242 Reclamation reservoirs or recreation areas totaled 54.2 million. Flood damage prevention varies widely from year to year; therefore, it is more useful to look at these benefits on a cumulative basis: since 1950, the value of damage averted has exceeded \$770 million.

## Economic Payoff

For an investment of \$6 billion over the past 70 years, the Nation is currently receiving an annual increase in economic activity of over \$4 billion. In addition to these benefits, the value of flood damages

averted in 1971 alone was \$68 million.

## Agricultural Impacts

*Irrigated crop production.*—The value of agricultural output from lands receiving Reclamation water, amounting to \$1.9 billion in 1970, represented 7.4 percent of the value of the national production of 70 principal crops. The value of crop production from Reclamation farms represents only 2.4 percent of all United States production of price-supported crops.

The assured water supply provided by Reclamation, combined with the western climate, allows project farmers to grow high-quality fruits, vegetables, nuts, and other garden crops that would involve high risk if a regulated water supply were not available.

Much of the national supply of fresh vegetables and fruits is grown on Reclamation lands. Much of this production occurs in late winter or spring and reaches retail markets off-season.

The distribution of crops grown on Reclamation lands is national in scope. About 40 percent of the fruits and vegetables received in 11 midwestern cities originate in the 17 Western States. Eleven southern cities receive 44 percent of their fruits and vegetables from Reclamation States.

*Food processing.*—Significant portions of the crops produced on lands receiving Reclamation water are ultimately processed into frozen, canned, etc. goods. The value added by food processors totals \$735 million.

The food processors located on or adjacent to Reclamation project areas offer another valuable service—they help provide a market for the output of surrounding farms. A market aids farmers in securing needed working capital, and promotes economic security and growth in rural areas.

*Livestock production.*—Further, several crops grown on Reclamation project lands are either partially or largely used in the livestock feeding industry. Value added in livestock production is about \$238 million per year. Approximately half of the beef cattle in the U.S. in 1969 were raised on farms in the 17 Western States. Thus, Reclamation project feed crop production provided support for the livestock feeding and packing industry of the West.

## Hydroelectric Power Impacts

Reclamation marketed 48.8 billion kilowatt hours of power in 1972, representing 10 percent of all electric energy produced in the 17 Western States.

Numerous electroprocessing industries in the Pacific Northwest are wholly dependent on Federal hydroelectric power. Without low-cost hydroelectric power, the major aluminum production industry in the North-

west would be dependent on other sources, such as coal, oil, and gas.

Federal customer utility disutilities. Reclamation investment in and assistance investment

## Recreation

Reclamation project facilities, exclusive of areas. The figures were percent of value (e.g., national

The recreation economic impact (1971). Full fit that measure duck, and provide

Economic reservoir recreation: applied man property tax revenue from recreation construction, recreation

## Municipal

The Reclamation important use. Over 666 nonagricultural water supply Program and the existing

## Environment

The favorable Reclamation Pro

west would not have developed. Similarly, other industries, such as phosphate plants in Idaho and Montana, are dependent on these power supplies.

Federal power sales are made first to preferential customers, such as rural electric power cooperatives, utility districts, municipalities, and State and Federal agencies. The remaining power is sold to electric utilities. Revenues from Reclamation power facilities, \$165 million in 1972, repay with interest the Federal investment in power generation and transmission facilities, and assist in the repayment of irrigation feature investments.

### *Recreational Impacts*

Reclamation projects provide a variety of recreational opportunities—sightseeing, camping, fishing, boating, and water-skiing. In 1970, recreational use of project facilities reached 54.2 million visitor-days exclusive of use that occurs on project-irrigated land areas. This use has grown rapidly since 1958 when figures were first reported and now equals nearly 7 percent of visits to all Federal outdoor recreation areas (e.g., national parks, monuments).

The recreation activity stimulates considerable economic impact (240 million estimated for fiscal year 1971). Further, there is an unquantified hunting benefit that occurs on Reclamation project farms. No measure exists of days spent hunting pheasant, quail, duck, and geese on the irrigated farming areas which provide prime bird habitat.

Economic impacts of recreation at Reclamation reservoir areas are substantial. Property values of recreational land near the reservoirs often have multiplied many times, with corresponding gains in property tax revenues. Also significant are economic impacts from recreationists' expenditures, and the annual construction, operation, and maintenance outlays for recreation facilities.

### *Municipal and Industrial Water*

The Reclamation Program has been an increasingly important supplier of water for urban and industrial use. Over 14 million persons in 168 urban centers were served 666 billion gallons of water for M&I and other nonagricultural uses in 1970.

Many large cities receive their major municipal water supply from Reclamation. The Reclamation Program also provides process water to make possible the existence of several industrial plants.

### *Environmental Impacts*

The favorable environmental aspects of the Reclamation Program outweigh adverse effects. The Pro-

gram has enabled man to inhabit many areas in the arid West and has had significantly favorable effects on wildlife, especially waterfowl. The many reservoirs, regulated reaches of streams, and irrigated croplands provide resting places, nesting habitat, and food for migratory waterfowl as they traverse the flyways of North America.

While dams and reservoirs have inundated portions of streams and interfered with the migration of anadromous fish, the reservoirs have provided large bodies of clear water and important fishing areas. In some



regions, such as the Great Plains, reservoirs have established fish habitats which did not exist under pre-project conditions. Year-round regulation of flows in some streams has created ideal environments for fish that did not previously exist.

Fish and wildlife enhancement is closely associated with recreation. Other favorable impacts are the control of floods and the nonpolluting sources of electricity provided by hydroelectric power installations.

A critical adverse impact of water development and use is the increasing salinity of some streams, notably

the Colorado River, and the build-up of alkalinity and salinity in some irrigated soils, especially where drainage problems exist. These salinity problems vary widely from one river basin to another. Their severity depends on several factors including the volume of stream flow, the use and reuse of water, the natural salt and mineral content of the soil in the drainage area, and outflow from saline aquifers into the streams.

The enhancement of the favorable environmental impacts and the correction or alleviation of the adverse effects in the future will require efficient water management based upon adequate research to determine the most acceptable methods and courses of action.

### *International Contributions*

The Bureau of Reclamation's history of international cooperation in water resource development dates from 1910 when Australia was aided in developing a reclamation law. Reclamation skills have been provided to foreign governments to improve their economic development. All costs of such assistance are borne by U.S. foreign aid appropriations, by the foreign governments, or by international agency funding.

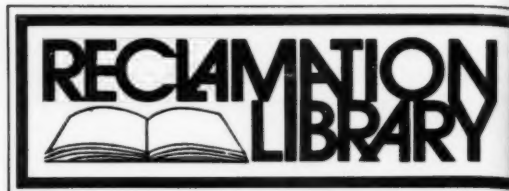
Reclamation publications, *Design of Small Dams*, *Concrete Manual*, and *Earth Manual* and others, are used throughout the world and have been translated into several languages. The Bureau's Foreign Activities Program has involved trainees and visitors from 123 countries—almost equal to the 131 membership in the United Nations at year end 1971.

### *Future Concerns*

There are a number of issues relating to the future of the Reclamation Program: Does the Nation need additional irrigation water capacity? What criteria and procedures should be used in evaluating proposed projects? What should be done with the multi-billion dollar backlog of authorized but unfunded projects? How should water pricing and repayment schedules be modernized?

A broader issue, both within and outside the Bureau, is how the Program can be adopted to changing national objectives and needs. Planning procedures are being revised to make new projects more responsive to these factors. Environmental impacts also are being carefully analyzed and incorporated into the decision-making process.

Finally, there is certain to be a continuing need for Federal involvement in water resource development and management in the West. The Bureau of Reclamation, with its background of accomplishments and expertise, appears to be a natural administrative mechanism to fill this continuing need.



*Environmental Guidebook for Construction.*—This pocket-sized booklet is designed to assist those concerned with the everyday problems of construction and to help them gain a clearer concept of what environmentalists want as it applies to construction work.

This handy reference gives helpful ideas and suggestions for on-the-job situations about specific aspects of environmental control. The booklet makes suggestions about such construction problems as burning trash, disposing of liquid wastes, controlling noise, protecting trees and natural rock outcroppings, and preserving land forms and characteristics to retain natural scenes.

A copy of this publication may be obtained by concerned organizations requesting it on letterhead, but supplies are limited and the booklet is not available in quantity.

Requests should be addressed to:  
Bureau of Reclamation, Code 910  
U.S. Department of the Interior,  
19th and C Streets, N.W.  
Washington, D.C. 20240

*The Bureau of Reclamation.*—By William E. Warne, a former Assistant Commissioner of the Bureau of Reclamation. This book tells the story of the Bureau of Reclamation, how it came into being, its struggle with the 160-acre limitation provision, and what its responsibilities are regarding dam-building, irrigation and hydropower.

Mr. Warne tells of the agency's relations with local water-user groups and other land-use agencies and his attempts to answer some of the questions that will face the Bureau in the future.

The book also describes the Bureau's major projects, identifies its leading personalities, pinpoints its problems and challenges, points out the need for change, and, above all, predicts how the Bureau will face its toughest test—that of relating its programs to the quality-of-environment requirements and making them compatible with the national resource programs of the coming century.

Copies of the book may be ordered at a cost of \$9.00 from:

Praeger Publishers, Inc.  
111 Fourth Avenue, New York, N.Y. 10003  
(Sales tax must be included where necessary)

# WATER QUIZ

1. The process of making water fit to drink requires removing impurities by filtration, precipitation, or chemical neutralization. What are some of the best materials used for filtering water?

2. The Ganga River rushes down from its fountain-head in the Himalayas, meanders across hundreds of miles of flat plains, and finally dumps vast amounts of silt into a delta. What was the river's name before India's independence?

3. As a stream curves around a bend, it moves sideways. True or false, why or why not?

4. Water is found in all three of its forms—ice, vapor, and liquid—on only three planets. Name them.

5. Although river floods are the most widespread water disasters that menace mankind, there are others equally deadly—notably hurricane floods (high tides reinforced by high winds) and tsunamis. What are the latter?

6. Efficient root systems in some plants absorb more water than they retain. Some is stored for later use. What happens to the rest?



Answers on back inside cover.

# news NOTES

## *Armstrong Becomes V.P. of URS Systems Corporation*

On April 1 Ellis L. Armstrong, former Commissioner of Reclamation, assumed the position of vice president of URS Systems Corporation, a nationwide multidiscipline professional services organization with headquarters at San Mateo, Calif. Armstrong will be stationed in Washington, D.C., but will spend a good portion of his time in California.

Armstrong will be responsible for special project development, with initial emphasis on water resources, pollution abatement, and energy-related services.

URS Systems Corporation is one of the largest nationwide publicly-owned professional service organizations, with a staff of over 1,100 active in the areas of urban and environmental analysis, planning, and design.



Ellis L. Armstrong

Former Commissioner Armstrong submitted his resignation to President Nixon last November and stated his service as Commissioner had been "a most rewarding experience." In a letter accepting the resignation President Nixon said:

"It is with considerable regret that I accept your resignation as Commissioner of Reclamation, effective upon the appointment of your successor. I do so with full understanding of your reasons and with a special appreciation for the contributions you have made not only to the Department's responsibilities in reclamation, but also to the achievement of this administration's goals."

In addition to his duties as vice president of URS Systems Corporation, Armstrong will be Chairman of the Board of the APWA Bi-Centennial Commission which will supervise the American Public Works Association's Bi-Centennial activities. This primarily will involve preparation and publication of the "History of Public Works in the United States from 1776 to 1976."

Armstrong is a native of Utah. He is the only man to have served as both U.S. Commissioner of Reclamation and U.S. Commissioner of Public Roads. He served as Commissioner of Public Roads during 1950-61, and had been Commissioner of Reclamation since his appointment by President Nixon in 1969.

During his career Armstrong has been engaged in worldwide activities in public works and in natural resources activities, having been involved in planning, design, construction, and management all over the world. He served in various capacities in the Bureau of Reclamation for over 23 years.

Armstrong served with consulting engineering firms for 12 years, including his assignment as project engineer for planning, designing, supervising, and managing the St. Lawrence Power and Seaway project for the Power Authority of the State of New York.

He is a recipient of a large number of awards and honors and is active in various professional organizations. One of his most important present activities is Chairman of the United States National Committee of the World Energy Conference.

## *Harry W. Bashore Dies*

Harry W. Bashore, Commissioner of Reclamation from 1943 to 1945, died April 1, 1973 in Colorado Springs, Colo. He was 92 and a native of Missouri. Before he became Commissioner, he served as Assistant Commissioner for 4 years.

A native of Missouri and a civil engineer graduate of the University of Missouri in 1906, Bashore began his career with Reclamation late that year as an engi-

neering aide in Mitchell, Nebr., at a salary of \$85 a month.

He worked on the North Platte project until 1924. Thereafter he was construction engineer on a number of major projects in Washington, Oregon, California, and Wyoming. When he resigned from Reclamation in 1945, he and his wife returned to Mitchell.

In 1952 he served as a consultant with the Department of the Interior and spent several months in Israel working on an irrigation project. Late that year he was named a member of the World Bank committee along with General Earle Wheeler. Their task was to work out a water rights treaty between India and Pakistan regarding the Indus River.

Bashore is survived by two children, four grandchildren and one great grandchild.

## Answers to Water Quiz:

1. Sand, gravel, and stones.
2. Ganges River.
3. True, because the water is subjected to centrifugal force. The water at the bottom is retarded by friction, hence moves more slowly than surface water. These influences combine to give a corkscrew movement to the water.
4. Mars, Earth, Venus.
5. Tsunami is the Japanese name for the most destructive water force—waves caused by seismic jolts or shiftings of the ocean floor (also known as a tidal wave).
6. It is either transpired through the leaves as vapor or forced out in the form of dewlike droplets.

## MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6073.....	Pick-Sloan Missouri Basin Prog., Trans. Div., S. Dak.	Dec. 4	Stage 06 Additions to Fort Thompson Substation.	Cochran Electric Co., Inc., Seattle, Wash.	\$253,969
DC-6074.....	Pick-Sloan Missouri Basin Prog., Trans. Div., Wyo.	Dec. 15	Torrington Substation, Stage 01 and Lyman-Torrington 115-Kilovolt Transmission Line.	do.....	646,782
DC-6076.....	Colorado River Storage, Trans. Div., Colo.	Dec. 29	Weld Substation, Stage 01.....	Addison Construction Co., Denver, Colo.	642,787
DC-6078.....	Central Valley, West San Joaquin Div., Calif.	Jan. 12	Earthwork, Pipelines, and Structures for Westlands Water District Distribution System, Contract 11B, Laterals 15R, 19R, PV2, PV3, PV4, PV8, and PV9.	C. R. Fedrick, Inc., Novato, Calif..	7,064,151
DC-6084.....	Parker-Davis, Ariz.	Feb. 13	Domestic Water Filtration System for Davis Powerplant and Community.	Woods Engineering & Construction Co., Phoenix, Ariz.	122,199
100C-1242.....	Rathdrum Prairie, Idaho.....	Dec. 8	Drilling Water-Supply Wells.....	Holman Drilling Corp., Spokane, Wash.	209,043
100C-1244.....	Columbia Basin, Wash.....	Dec. 13	Drains and D83-7 Pumping Plant—Block 83.....	John M. Keltch, Inc., Pasco, Wash..	306,284
100C-1247.....	do.....	Dec. 19	Drains Block 20.....	Roy Johnson Construction Co., Inc., Ephrata, Wash.	154,609
100C-1249.....	do.....	Jan. 26	Drains, Blocks 85 and 87.....	John M. Keltch, Inc., Pasco, Wash..	385,910
200C-571.....	Central Valley, Calif.....	Feb. 12	Friant Dam O&M Headquarters Office Building..	Remco Construction Co., Clovis, Calif.	130,517
400C-517.....	Emery County, Utah.....	Dec. 11	Block No. 1 Drains.....	Ed Lohoff Construction Co., Kersey, Colo.	153,363
400C-519.....	Colo. River Storage, Ariz.....	Feb. 22	Bituminous Surfacing, Glen Canyon Dam.....	Dean Slavens Construction Co., Flagstaff, Ariz.	101,396
500C-513.....	Mountain Park, Okla.....	Jan. 24	Earthwork and Minor Drainage Structures for St. Louis-San Francisco Railroad Relocation.	Cornell Construction Co., Inc., Clinton, Okla.	791,683
604C-92.....	Pick-Sloan Missouri Basin Prog., Helena-Great Falls Div., Mont.	Feb. 6	Dredging for Westside Pond, Canyon Ferry Dust Abatement.	Capital Dredge & Dock Corp., Lorain, Ohio.	1,846,500
701C-785.....	Pick-Sloan Missouri Basin Prog., Bostwick Div., Kans.	Jan. 18	Earthwork and Structures, Courtland Canal Sub-surface Drain 31-2-6 Section 2.	Subsurco, Inc., Grand Island, Nebr.	146,930

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